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ABSTRACT

Items in the North Central Regional Educational Laboratory's (NCREL) School Development Library series are multimedia packages consisting of print, video, and CD-ROM resources designed to support educators in their efforts to improve classroom instruction. This particular set consists of a 40-minute video and a printed booklet focusing on Dwight Cooley, a fourth-grade teacher. The video of his classroom shows him teaching a math lesson based on authentic tasks and collaborative learning. Dwight places an emphasis on the problem-solving process, thus students are obliged to explain their strategies in both large and small groups. It is actual footage of a fourth-grade classroom and is divided into 18 events, each division representing a change in the activities or flow of the classroom. The text of the booklet is based on spoken comments made by various people as they watched the video. The booklet's intent is not to be a verbatim transcript, but rather to capture the viewer's reactions to the classroom. (JRH)

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ED 410 116

School Development Library

A Fourth-Grade Math Lesson With Dwight Cooley

Dwight Cooley is a fourth-grade teacher. The 40-minute video of his classroom shows him teaching a math lesson based on authentic tasks and collaborative learning. Dwight places an emphasis on the problem-solving process; thus students explain their strategies in both large and small groups.

Solvers

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A Fourth-Grade Math Lesson With Dwight Cooley

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1900 Spring Road, Suite 300
Oak Brook, IL 60521
Jeri Nowakowski, Executive Director

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Project Director/Executive Producer ..... Randy Knuth

Senior Researcher ..... Beau Fly Jones

Coproducers ..... Louis M. Ciancio Jr.
Debra Friel

Project Manager/Instructional Design Specialist ..... Debra Friel

Program Coordinator ..... Steve Baxendale

Video Editors ..... Louis M. Ciancio Jr.
Steve Garnett
Gail Hutchison-Marshall
June Yang

Production Assistant ..... Felicia Lawson

NCREL Perspective ..... Cathy Cook
Todd Fennimore

Narration ..... Louis M. Ciancio Jr.

Graphic Designer ..... Melissa Chapko

Senior Print Editor ..... Lenaya Raack

Print Production ..... Cheryl May
Dana Haugen

NCREL's School Development Library consists of video and print resources designed to support educators in their efforts to improve classroom instruction. These materials include audiotapes, case studies, the *Pathways to School Improvement* Internet server, print guidebooks containing teacher and expert commentary, video programs and videotapes of actual classrooms, and CD-ROMs, which include both a classroom video and the guidebook in electronic format.

The classroom videos are not scripted; they provide an example of real elementary or high school instruction to be used as models or cases for educators to study. They are examples of good instruction that is consistent with established and developing content standards. These videos are designed to be used as part of an ongoing professional development program that includes the use of other classroom videos, information, and resources.

Some of this material was adapted from Strategic Teaching Framework (STF), an NCREL/IU hypermedia project, under the direction of Thomas Duffy, Professor of Instructional Systems Technology at Indiana University; Beau Fly Jones, Senior Researcher and Director of the Teaching and Learning Center at NCREL; and Randy Knuth, Director of the Center for Scaling Up at NCREL.

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Dwight Cooley

Suggestions for Using the Perspectives With the Video

Dwight Cooley is a fourth-grade teacher. The 40-minute video of his classroom shows him teaching a math lesson based on authentic tasks and collaborative learning. Dwight places an emphasis on the problem-solving process, thus students explain their strategies in both large and small groups.

The video is actual footage of a fourth-grade class taped during June. The tape is divided into 18 events, each division representing a change in the activities or flow of the classroom.

The Dwight Cooley Perspectives booklet is designed to be used with the Dwight Cooley video. The text in this booklet is based on spoken comments made by various people as they watched the accompanying videotape. NCREL tape-recorded, transcribed, categorized, and, in some cases, condensed these comments. This booklet's intent is not to be a verbatim transcript, but rather to capture the flavor of the viewer's reactions to the classroom. The perspectives are those of Dwight Cooley, the classroom teacher; Dr. Bill Leibfritz, Professor of Mathematics Education at Central Michigan University; and the NCREL project team.

We suggest that you use this booklet as you view the video to add insight into the instructional methods used in the class.

Event 1 Introduction to lesson

Classroom Management

Dwight Cooley

This is a fourth-grade classroom with heterogeneous groupings. We have students at all skill levels, and you'll find that all the students will be involved. When we are doing group assignments, I give them an option to choose a couple of places where they can sit. If there's a group that is not mixing well, I will suggest to or ask someone if he or she wouldn't mind moving to a different place. Usually cooperation is fine, and I haven't had any problems thus far.

In my classroom, any response is a good response. Although there were several different ones, everybody felt like they were contributing, and there was no snickering—that's one thing we don't allow. We respect each other's opinion. The kids have really done a good job at accepting that. They feel strongly that no one should laugh when someone gives an answer that may not be where we think we may be going.

Bill Leibfritz

From a classroom management standpoint, it is obvious that this teacher has set a very good tone. Classroom Management is not something that you can change immediately, and he has obviously set a good tone because the kids are very well behaved and very much on task.

Teaching Strategies

Dwight Cooley

At Carlson, our curriculum is project based. We try to bring in many real-life opportunities for our kids to experience, whether they be mathematics, language, science, or what have you. NCTM standards call for students to experience mathematics through real-life situations. This newspaper article offered an opportunity to really tie into the real world. At this time, I'm asking them to infer about the titles. I'm tapping into language arts. I'm trying to see what they're getting from the article already—what they think may be there. Basically, I'm setting the stage for what may happen or what's going to happen as we get into the task. We'll get to the point where you see some

Teaching Strategies, cont.	
Dwight Cooley, cont.	things happening as far as students being really engaged—I mean you can see it all over their faces, just how serious they are about what's going on. That's the nature of the real-life experience. We had experienced some recent drownings of school-aged children here in the area, and they know about them. They all love swimming, so when I asked them about summer fun, they talked about being rowdy and having fun outside. That was my way of getting them to focus, to get them involved in the task.
Bill Leibfritz	Dwight is moving around the room, asking the kids questions, requiring them to search for information versus telling them, obviously a very strong strategy.
NCREL/IU	Dwight did a really good job of using some of the principles of strategic learning, especially as they apply to reading. He first had the children read the title of the article and make a prediction about what they thought the article would be about. Based on those predictions, he also had them activate their prior knowledge about the topic—the summer—and tried to get them to reflect on some of the activities they did during the summer. After that, they delved a little more deeply into the article. Dwight situated the learning activity in a meaningful, real-life problem, safety around the pool. He connected the event to something they were all familiar with, recent events where one child was drowned and another one hurt in a swimming pool. This made the problem seem very immediate and real to them.

Event 1, cont. — Introduction to lesson

Problem Solving	
Bill Leibfritz	From the problem-solving standpoint, he is relating back to things that have happened previously that the kids would have information on. This is a strong strategy to use.
Assessment	
Bill Leibfritz	Dwight is constantly questioning and asking students, "What does this mean?" to get a feel, informally, for whether they are comfortable and at the right level for what he is trying to do with this article.
NCREL/IU	Dwight used excellent questioning strategies by asking open-ended questions rather than yes/no questions. He asked "how" and he really tried to press some of the higher levels of thinking through the questioning. Dwight demonstrated that he really cared about the kids' thinking; however, he could have taken it a step further as well and asked them questions such as, "Why do you think that is the case? Where do you think the problems might come in?"

Event 2 Setting up the task

Classroom Management	
Bill Leibfritz	Dwight uses his questioning skills and movement around the room as a management tool. It appears that he is calling on kids who probably are not raising their hands, squashing the idea that, "If I don't raise my hand, I won't be bothered." He is trying to keep everyone involved, maybe by purposely going to kids who don't seem to be involved and making them get involved, and that is a management strategy to get everybody going.
Teaching Strategies	
Dwight Cooley	On the second page, we got to the actual task itself. I read the task from start to finish and had them follow along. I did that because I wanted them to understand it first, then I went back later and asked them what I had read. When Darrell said, "I'm trying to find the perimeter and how much fencing to put around the pool," he was already formulating a strategy. With the NCTM standards, communication is the big thing. I believe in letting them fully explain to me exactly what it is we've got to do before we move on.
Bill Leibfritz	He is posing questions, having the students think about what the problem is asking.
NCREL/IU	Dwight did a good job of using an authentic task embedded in a real-life role. He reviewed the problem with the children, making sure they understood the nature of it and the sort of information they needed to gather to address it. Through the use of the hand-out, he structured the phases of problem solving that they would expect to go through as they addressed the task. In this way, he was helping them develop skills in the problem-solving process. Ordinarily, kids would jump right in to solve the problem, so depending upon the time of the year, it is probably very appropriate for them to develop skills through this type of a classroom structure.

Teaching Strategies, cont.

NCREL/IU, cont.

An alternate strategy to reading the problem out loud all at once is to use the overhead projector and pace out the problem, exposing a little bit of information at a time and posing questions to access kids' opinions and thoughts about what they think will come next.

The problem itself was really a nice problem in that it was very research oriented. The kids were asked not only to deal with measurements, but to analyze the data and the problem and to make some judgments about the best types of materials to use. As the NCTM standards recommend, the computation is embedded in a problem context.

Problem Solving

Dwight Cooley

Now when I mentioned the task, there's meaning within this word. When they hear the word *task* , they know it's something they're about to perform; there's something they're about to do now; there's a mission. In a performance task, students will have to accomplish a series of steps; they will have to go through a series of procedures; and there is a mission—a point where they have to get to—and they'll have to go through a series again of different types of strategies, different reasoning. This didn't just happen overnight. They were used to sitting down, doing the worksheets, turning them in, and getting a grade, but here we have a performance task. We've talked about the fence around the swimming pool, and that will help them make the connection when we start talking about the perimeter of the swimming pool. So, again, this is our way of linking real-life aspects to the content area, which, of course, is recommended by NCTM.

Fourth graders often confuse the concepts of perimeter and area. This was my way of isolating what this perimeter is and isolating it in a way that makes sense to them and puts it into a

Problem Solving, cont.	
Dwight Cooley, cont.	real-life context. There was also a lot of problem solving throughout this task. There was a lot of reasoning going on, but the concept of perimeter was the main focus.
Bill Leibfritz	Dwight is not just giving the students a problem, he is talking through the problem to make sure they have a clear understanding of what is being asked. That is critical in a problem-solving situation. The problem needs to be relevant to the kids. It is something that kids can visualize: a swimming pool, a fence around the pool—all those things are probably familiar to most of these kids. The NCTM standards stress the need for problems to be relevant to kids. Some of the difficulties that we have today with the problem solving in classrooms is that the problems kids get don't mean anything to them. This problem obviously would have some meaning to the kids and Dwight stresses that. When he asks questions, he tries to clarify, bringing out each important point. He keeps questioning until those important point are brought out, calling on different students, not relying on one student the whole time. This is critical; the standards stress that kids need to understand what is being asked before they start working on a problem. Many kids incorrectly solve problems because they don't know what is being asked.
Assessment	
Dwight Cooley	I'm listening for any misconceptions they may have. If there's a gap and someone else doesn't fill it, then I will. Generally, what will happen is everybody is listening and as one person is giving his or her thoughts, someone is saying, "Okay, but he left that out" or "He forgot about this." In the end, everyone pretty much understands what the task is and when they work in groups, what one may miss, the other one will pick up.

Assessment, cont.	
Bill Leibfritz	This is his way, again informally, of finding out if the kids understand what is being asked. Once they can do that, once they do understand what is being asked, they have a much better chance of solving this problem or at least working in that direction for a correct solution.
NCREL/IU	Dwight brings in students who otherwise might not be brought into the conversation, and he doesn't allow other students who are a little bit more assertive and confident to dominate the conversation.

Event 3 Students clarifying the task

Teaching Strategies	
Bill Leibfritz	Dwight is still questioning, still trying to make sure that the kids have an understanding of what the problem is going to deal with, but now they have a little more information. Again, along this line, Dwight incorporates the teaching strategy of using things that make sense to the kids.
NCREL/IU	Dwight uses original information sources in presenting the task, a newspaper article, and the information needed for the task, advertisements for fences. He helps them interpret those sources of information and connects it to their experience. Have they, for example, seen a wooden fence installed? Does it come in one big piece? What does that mean for how they go about interpreting the information in the ads?
Problem Solving	
Dwight Cooley	Geoff uses mathematical reasoning when he said that the fence is six feet tall because it is barely over the man's head. Geoff said the word "because," and then he went on to explain his answer. The students know that I'm probably going to ask them to tell me more than just the answer.
Bill Leibfritz	In this event the one boy was asked about the height of the fence, whether it was 6 feet or 8 feet, and he used information that he knew, that the fence is just slightly over the head of the fellow in the picture. It would be very rare that this guy would be over 7 feet tall, so the student figured that the 6 foot figure is for the height. He is using information he already has. The NCTM standards request teachers to use information that the kids already know. This makes for better problem solvers when the students see that they can use information that is not written in the problem.

Assessment

Dwight Cooley

When I asked Stephanie to tell me about that ad, I was trying to get some prior knowledge. I was trying to find out what it was I was going to have to tell them. Stephanie went through the ad sheets and talked about the size and the cost, and she identified it as a fence panel. I feel okay that she understands what that particular graphic is about. I'm going to make sure all of the students completely understand the main information here, and that's the length and the width of the panels and the chain and the prices. At different points, there are different things I want to make sure they understand, and I want to level the playing field so they can be successful on the task. I may ask questions specifically for that purpose, and sometimes I will probe more, and that's just when it's not so clear.

Bill Leibfritz

Dwight is still making sure the kids understand the problem, and he is making certain they are aware of all the information that is available to them. When a teacher does this, he or she then knows that the kids will have a better opportunity to solve the problem. They will then have a better problem-solving experience and will probably be more likely to attempt other problem-solving situations, which will help the teacher's classroom management. It is almost like a computer loop—one thing leads to another.

NCREL/IU

At first Dwight relied very closely on yes/no questions, but he eventually probed and asked some questions like the one he used with the 6 feet high or 6 feet wide issue. He asked, "Why do you think... ?" and then he got that very rich response from the boy who compared the picture to people's height. As soon as he started asking those more open-ended thinking questions, they were really at the analysis level. He used a balance of different types of questions so that students of all ability levels could successfully respond to questions—direct questions that just asked for an explanation of the information and probing questions that were more challenging. The students looked like they felt confident about responding, and a lot of them had their hands up as opposed to just a couple.

Event 4 — Reviewing roles and responsibilities of group members

Classroom Management	
Dwight Cooley	What I try to do is to help keep everybody on task by giving them a role and letting them feel like they're really playing a part in this, and it works. It goes back to cooperative grouping. On your job, when you're in organizations, you have facilitators, recorders, secretaries, and so on. We wanted to get into the mindset of the real world, like the workplace for adults. When you first start to do cooperative grouping it is noisy, but after they practice and go through it a few times, they do it well. By having a role or title, they feel important.
Bill Leibfritz	The kids are obviously now focused; they are starting to get interested in the problem and that certainly helps. If you give kids problems that they are interested in, they are going to think about the problem, and they are not going to think about disruption.
Teaching Strategies	
NCREL/IU	During this event, Dwight is moving from whole group to small group, and he is basically helping the students with directions about their small-group tasks. By structuring the small groups with roles, he fosters interdependent behavior.
Problem Solving	
Bill Leibfritz	Dwight is going to give the kids a chance to do some things in a group; again, this is a cooperative learning situation. The old adage that two heads are better than one obviously is true in a problem-solving situation. Business is telling us that. Kids need to be able to solve problems together. Oftentimes it isn't effective to solve problems by yourself, although those skills are also necessary. Sometimes we are better off solving problems with somebody else or with a group. We all bring different things to a problem-solving situation, and it works better if we could put those strengths together versus each one trying to do all the

Problem Solving cont.

Bill Leibfritz cont.

necessary things to solve a problem on their own. The NCTM standards talk about the need to solve problems in groups, in cooperative learning situations.

NCREL/IU

Dwight is asking them just to explore advantages and disadvantages in order to make some decisions about types of fences, so he is breaking up the planning phase of problem solving into subparts. At the beginning of the event, he is asking the students to talk about what is meant by advantages and disadvantages, and he asks the students to give an example. One of the things that Dwight might have done at that point is to work with the girl who answered, asking her to rephrase what she meant by the advantage and why it was an advantage, to provide a good example for the rest of the students about the difference between advantages and disadvantages. It seems a little complex because they are dealing with advantages and disadvantages of both chain-link and wooden fences, so it will be interesting to see how the students actually record that information.

Assessment

Dwight Cooley

When you do cooperative grouping, you can generally tell when somebody is not doing what they need to do. When they're talking among themselves, that's when you can really assess a lot of things as far as how they're able to work with other people and if they are able to accept other people's opinions.

Bill Leibfritz

Dwight continues to ask questions. In this case, though, with the kids in cooperative groups, he is making sure that each person within the group understands what they are to do. He doesn't tell them; rather, he asks, "What is your role?" Oftentimes we tell children what we expect them to do, but we don't ask if they understand what they are expected to do. Dwight does that. He asks, "What is your role as the facilitator? What is your role as the recorder?" and he makes sure that they know that.

Event 5 — Students working in small groups choosing wood panels or chain-link fence

Classroom Management	
Dwight Cooley	When the kids are working in their groups, I know who's sitting where, and I know their voices, and when I hear one above the other, then I can generally tell what's going on. I give them the confidence to take responsibility for their learning. I want them to know I don't have to stand right there beside them for them to be doing what they need to be doing. They appreciate that and, in the end, they appreciate that trust. "Okay, Mr. Cooley can go on and we'll take care of this, and when he comes back, we'll have this ready for him." That's the attitude they like to have.
Bill Leibfritz	The kids are working in groups, asking questions, and giving their opinions about the strategies and the type of fence to use. Obviously, the kids are focused, which is a good classroom management skill. Dwight has built up to this. He didn't just dump it on them. He lead up to the situation where there can be a little bit of noise and a good bit of focused discussion. A quiet classroom does not always mean a learning classroom. There is obviously a lot of learning going on here.
Teaching Strategies	
Bill Leibfritz	Dwight is floating around the room. He is not just standing there and letting the kids do the work. Cooperative learning does not mean that the kids do everything. Everything is done in the group, and the teacher goes around and checks and questions.
NCREL/IU	In his facilitation role, Dwight does a really nice job of eliciting responses from students who aren't participating as much in the process. He specifically picks out students and poses a question to either check their understanding or to involve them in the problem-solving process. One of the things that he can do more of is to facilitate the interdependency of students. Very often when he approaches a group and poses a question, they respond to him as opposed to responding to one another. One of the things that is a difficult part of the facilitation role is to help students rely less on "you" and more on one another.

Event 5 cont.	Students working in small groups choosing wood panels or chain-link fence
Problem Solving	
Dwight Cooley	I call myself a coach. I like to make them recognize what it is that's holding them up rather than me telling them. I felt that they could recognize their problem and the reason why things were not happening, and then they would stand a better chance of solving it. We talk about how we can deal with it. "What are some ways you think we could do it? How can we do it? Let's do it!" I asked the last group in this event how they were going to decide, and they said that they would vote on it. I'm not going to say "Yea or nay." If they decide they want to vote, they will vote. They appreciate having the opportunity to make a choice on what they want to do versus me saying, "Okay, we'll do it like this." A lot of teachers say, "We'll do it like this." So when I ask them if this is something that everybody can live with and they say that they can, then that is what they do.
Bill Leibfritz	From a problem-solving standpoint, the kids are questioning. They are trying to think about different options. Dwight is making sure that each kid within the group is having an opportunity to get his or her opinion out. Some of the groups obviously have stronger kids than others, but the teacher is making sure that some of the less assertive kids voice their opinions. Yet Dwight seems to be using the strengths of these stronger kids, to let them lead, but not dominate the show.
NCREL/IU	In this event, the students have to make a choice. They are not engaged in a process of articulating the important criteria in making that decision and thinking about how to weigh the criteria in order to ultimately come up with a recommendation of one fence over another. They are not given some kind of structure for organizing the information that would be relevant to the decision, such as using a matrix. Because there isn't that kind of exclusive scaffolding of their decision making, it seems that there are two things that happen. First, the kids focus a lot on making a choice. Dwight frequently emphasizes making a choice rather than the process of making the decision. Second, because Dwight hasn't

Problem Solving, cont.

NCREL/IU, cont.

explicitly had them articulate the criteria, they tend, by default, to think about safety concerns only. There may be other criteria that they need to consider as well, and because that hasn't been made an explicit part of the decision-making process, they don't look at them. They have just been discussing the safety of children, so their discussion continues along that line.

Assessment

Dwight Cooley

I just kind of move around and find out where everybody is, and then I can tell if they need more time or not. Sometimes I ask them to signal me by waving or putting their pencils down or something else like that to let me know they have completed a part. Then I'll go over and just kind of talk to them about it and make sure they're there. Basically, I just kind of let them go on until I see that they have accomplished their goal.

I listen for misconceptions in their problem solving as well as problems with the group process. I think that the majority of my assessment is listening to them talk. Anytime I hear a misconception about anything, I'm going to try to clear it up. I believe in clearing it up right then. Most of the time, it's just a matter of a little dialogue—a question or two to find out what they're thinking. I ask, "What is it that makes you think that's the way to do it, or what is it that makes you think it's like that?" We'll try to find the root of it and try to clear it up from there.

Bill Leibfritz

Dwight is assessing, making sure that each kid is involved. The kids are talking about perimeter, length, and width. There are a lot of geometrical terms being used—but in a very practical sense—and the kids are using those terms in some of these discussions. One girl made an interesting point relating to height; that is, How high should the fence be so that a child can't climb over it? She pointed out that if it is too high or if it is made of wood,

Asssessment, cont.

Bill Leibfritz, cont.

you won't be able to see through it, and if something goes on, you may not know about it. The NCTM standards talk about the fact that the problems need to be practical. They need to be things that kids can relate to. So asking them to find only a perimeter, or a height, or a width, or whatever it might be, for its own sake, isn't really meaningful to kids. Relating it to the aspect of a fence, however, does make it meaningful. This problem obviously is meaningful to these kids and they are getting very involved.

Event 6 — Whole class discussion – Students reporting their choices and discussing perimeter

Classroom Management	
Bill Leibfritz	The kids are getting more involved in the problem. I think one can see throughout this tape that good teaching can become one of your best classroom management tools.
Teaching Strategies	
Dwight Cooley	Because of the grouping situation and to make sure that everybody is where they needed to be, I decided to take one question at a time. Now we are moving on to the second question. This way, it kind of kept everything flowing. Nobody fell behind. I think that they gave more input because this was the only thing that they had to deal with at the time.
NCREL/IU	It seems that there is a lot of emphasis on the decision made, rather than looking at the process of decision making itself. There is a great opportunity here to debrief on what the various small groups came up with for advantages and disadvantages and to synthesize that somehow—perhaps by using a matrix, but certainly by articulating as a whole class the kinds of criteria that are being considered. He really misses that opportunity by emphasizing the choice and moving immediately to the second question, which has a lot to do with implementing the decision, rather than looking more at the planning needed to do the decision making, the data gathering, the articulation of the criteria, and the weighing of the criteria. Again, because there is no exclusive phase where they articulate the criteria, they seem almost by default just to consider safety. But clearly things like cost, aesthetics, and other issues come into play when you are trying to make this decision. If you were trying to make this decision in real life, you would be considering a broader range of criteria. There could be more of an emphasis on the planning and thinking involved in making a decision.

Event 6 cont.	Whole class discussion – Students reporting their choices and discussing perimeter
Problem Solving	
Bill Leibfritz	Dwight is trying to clarify what the students are doing. He is questioning each step. Problem solving is often a long process. It is not something that can be solved quickly by reading a problem and then doing some kind of computation. They are going through the process, getting a feel for where every group is.
Assessment	
Bill Leibfritz	Dwight is determining the kids' understanding of what they are doing. Are they ready to move to the next step to become a little more specific?

Event 7	Students working in small groups figuring out perimeter
Teaching Strategies	
Bill Leibfritz	Dwight is moving around the room trying to find out what the kids are doing and the reasoning behind the decisions they are making. Dwight sees if they can put into words, "Why do you think this?" Oftentimes we don't question why a kid does something. Instead, we just look at what they did. We can find out a lot more when we ask, "Why did you do something?" versus "What did you do?"
NCREL/IU	One of the most difficult things to do in small-group cooperative learning is to help kids actually feel and develop an interdependence within the group. Dwight is trying to facilitate that by asking students to share with one another. A teacher also could not provide a calculator, pencil, and paper for every student. This would force them to work as a team.
Problem Solving	
Bill Leibfritz	The kids are using calculators. We need to allow kids to use tools that are available, and calculators are a very valuable tool. That is all these kids are doing—just using the technology that is available to them. It is not impeding their problem-solving process—if anything, it is enhancing it. The kids are also continuing to work together. Dwight says, "Look at what so and so has," and the kids look at each other's work. This shows that there is another way to do it, and it encourages the students to look at all the possibilities. I think that Dwight is encouraging students to work together so that they can think together and look at their individual strengths and learn from each other.
NCREL/IU	The one girl did a very nice job of articulating the need to have a chaise lounge and other items factored into the distance that the fence needs to be from the pool. Dwight seemed to focus a lot on "Oh, okay, so it is 15 feet," rather than, "Oh, I see why you are reasoning that, because you are considering not only the fact that people have to walk around the perimeter, but there might be other

Event 7 cont.	Students working in small groups figuring out perimeter
Problem Solving, cont.	
NCREL/IU, cont.	items that you want to enclose within the fence, so you have to think about that." He could have brought that out and emphasized the reasons behind arriving at that particular quantity. One child realized that the 15 feet needed to be added to both the length and the width and all around the pool, and Dwight encouraged him to share that thinking, thus advocating collaboration among students.
Assessment	
Dwight Cooley	Students get a chance to clarify how they're thinking when they talk about it. If you notice, Tansia went around three or four times and she back-tracked and came back until she finally was able to say what it was she wanted to say. A lot of kids don't get a chance to communicate, don't get a chance to talk, so they end up out there in la-la land and are confused. After they told me their fifteen feet, I asked them, "Okay, well what's the next step?" I wanted to find out if they were still on task and if they understood what to do next. Koger has an idea that he must add fifteen feet, but he's not sure he has to add 15 feet all the way around. So, now I'm trying to get him to understand that he has to do it all the way around. That's one of the misconceptions that I'm always looking for. If somebody in the group is on target, then we're okay because what's going to happen is they are all going to collaborate. If one or two people are off, the one person who is on will generally bring them into line, and that's what Noah did. He said, "What's the sense of putting it on there if you don't change the dimensions?" What we're working on right now is getting the dimensions changed.

Event 8 Dwight working with small group

Classroom Management	
Dwight Cooley	Arden was kind of out of the picture for a little bit, so I moved over so I could be close to him. He will get off task if he's away from it because he can't move around as much as he wants. That is why I moved a little closer to him so I can make sure I got him in.
Bill Leibfritz	One thing that I think is very important to note here is that Dwight is able to give this group his full and undivided attention because the other groups are working on the problem and they are not disrupting. Dwight has set up a situation where he can go to each group and not have to worry about what the other groups are going to do. Is somebody going to disrupt? Is somebody going to draw my attention in such a way that I can't give this group my attention? Well, he doesn't have to worry about that. It is obvious from his manner and his style that he probably hasn't had to worry about that for a long time.
Teaching Strategies	
Bill Leibfritz	Dwight is working with the groups; he is not telling them what to do. He is letting the kids answer the questions and drawing information from the kids.
Problem Solving	
Dwight Cooley	It took this group a little while to get there. I just talked with them, let them go step by step, did a little probing, and they eventually came around. José was just adding nine. A lot of them were just stuck on one side. They forgot about the other side, and by me just probing, they came around and said, "Okay, well 18."

Event 8 cont. — Dwight working with small group

Problem Solving, cont.	
Bill Leibfritz	Dwight has chosen a problem that the kids will be interested in and they can relate to. I think this is critical in the problem-solving process. Oftentimes the problems in textbooks aren't things that kids can relate to.
NCREL/IU	The students were highly interdependent because they were really focusing on one product and sharing their thinking through the use of one diagram. All of their heads were together and they were really listening. Basically they were checking on themselves as opposed to Dwight checking on them.
Assessment	
Bill Leibfritz	Dwight is still trying to make sure that the kids are at a certain point. He is not moving ahead until most of them are at that point. The kids are coming along at their own pace. The strong kids are taking over certain aspects, and the other kids are learning from them. You never know how that is going to work—how it is going to happen—but it tends to be very positive.
NCREL/IU	Dwight does an excellent job here of helping the kids articulate and assess the way that they are thinking. He makes very effective use of a visual—a diagram—to help the kids reflect on and explain their thinking, and, in this case, to correct a frequent mistake. Children often add to one side without adding to the other sides, and Dwight helps them to self-correct on that through their own assessment.

Event 9 — Whole class discussion – Group one reporting their findings

Teaching Strategies

Bill Leibfritz

The kids are reporting their decisions and explaining why they did what they did. There is some ownership: "It is not just my problem. It is my group's problem." It is very effective for kids to work in cooperative groups. This strategy takes the pressure off of a lot of kids who don't feel comfortable solving problems because they don't have to do everything themselves. They can add their strength, feel good about that addition, and probably be more willing to solve problems at another point.

Problem Solving

Bill Leibfritz

The class is dealing specifically with the problem-solving idea and is now reporting back information. "This is what our group found. This is what we got. This is why we got it." Again, Dwight is not questioning whether it is good or not. We, as teachers, need to think about this more. Often in the past problems were either right or they were wrong. In this situation, there are many different possibilities. The standards talk about that. Kids need to see that problems don't always have simple, one-answer solutions. Oftentimes there are many different types of solutions. Some may be better than others, but it doesn't necessarily mean that one is wrong. This problem is more realistic, going back to the notion that it is a problem that kids can relate to. There may be a best answer, but there are many possibilities, and the kids are working along that line. This is much more realistic than many problems they have probably seen in the past.

Assessment

Bill Leibfritz

Dwight is continuing to find out what the kids have, what they understand, and how they got to that point. How they got their answer is more important than the answer itself.

Event 9 cont.	Whole class discussion – Group one reporting their findings
Assessment, cont.	
NCREL/IU	In the reporting back, the students did an excellent job of articulating and describing their entire process. At the beginning, Dwight did not ask them to describe how they got their solution, but in the end, he did ask them to justify the cost. Because of the prevailing classroom climate, the students knew they were expected to be pretty thorough about the way they described their solutions. They also were using math language well. The one boy corrected himself when he said "times" by changing it to "multiplied by," which shows that they were consciously thinking about expressing their solutions using math language, which relates very well to the NCTM strand of communicating their thinking.

Event 10 — Whole class discussion – Group two reporting their findings

Teaching Strategies	
Dwight Cooley	Lee is off track right now as far as determining how much money is concerned. This is where I mentioned a past activity with the stock market, and that is going to trigger his thinking about the money. He talked about exactly what we did to find out how much it pays, so I'm trying to make some connections again. Now they feel good, and the way that I left them, saying, "Thank you," that was a form of praise for them. This is the way that I deal with them every day. They can hear from my voice that I was happy, and I was satisfied with what they said, and it left them with a confident feeling, especially Lee. He didn't want to tell me everything, so I had to stay with him until he finally told me, "It's the panels times the money." Now I have two experiences I can refer them back to—the stocks and the panels—if something else ever comes up like that. I try to use prior experience as much as possible.
Bill Leibfritz	Dwight has located a group that needs a bit more attention, but not dramatically more. The one student is slightly confused on how he is going to figure out some cost. Dwight asks questions. He doesn't tell the kid what to do, and he asks the kid to come up with the solution. Here he does again what the standards ask us to do—he relates this problem to something these kids have done in the past with the stocks that they bought. He is relating one problem to another, looking for the relationship: "We did this in a problem we did earlier; relate that back to what you are doing now." Mathematics is a science of relationships. Often times kids see math as a bunch of isolated topics. Teachers need to help kids see that math has relationships. One problem can relate to another. Sometimes what you do in two problems is the same; it is just different situations. In this case, Dwight is relating it back to the stocks.

Event 10 cont.	Whole class discussion – Group two reporting their findings
Problem Solving	
Bill Leibfritz	Dwight is questioning their answers: "How did you get what you did?" Now you are beginning to see computation aspects come in, but there are concrete aspects behind the computation in this problem-solving situation. The kids want to do that. They want to see why they multiply this times that, or that times that. Dwight keeps questioning, "Well, what do you get when you do that? Not just what number do you get, but what does that tell you?" Again, oftentimes kids can do computation but don't know what the answers are telling them. At that point, you need to question what good the ability to compute serves if you don't know what that computation is actually telling you—not from a solution standpoint, but if you multiply 6 x 3 and get 18. It is 18 what? What does that 18 have to do with the problem? That has more value, and Dwight is pulling that out.
NCREL/IU	Dwight was skillful here with helping kids critically think about what operations and quantities they were using, and what kinds of answers they would generate from using them. He does a good job of referring to a previous problem that they worked on with stock prices, and of getting them to reactivate the knowledge they had acquired in that problem situation.
Assessment	
Dwight Cooley	Noah talked about rounding. He talked about 37.5 and rounding it up to 38. This is his prior knowledge, his prior experience. Now when I come up to some type of activity that involves decimals, I know Noah has some prior knowledge already.
NCREL/IU	Dwight really had a keen understanding of where each group member was relative to the process. Rather than just having one person report back from the whole group, he checked for everyone's understanding and active listening during the reporting back process by posing questions to individuals to get them to continue on from where the last person left off. He uses a lot of probing questions and really delves into their understanding of the problem.

Event 11 — Whole class discussion – Group three reporting their findings

Classroom Management	
Bill Leibfritz	From a classroom management standpoint, you can see another good example of the fact that Dwight can give his full attention to this group and not have to worry about the others. That is very critical. Teachers can't do their jobs if they always have to worry about what another group is doing. Dwight set that tone.
Teaching Strategies	
Dwight Cooley	I'm trying to help José out here. I was trying to get him to remember about perimeter, and I gave him the gesture "around." He gave me two dimensions, and I was trying to get him to take it from this gesture, "Okay, give me all the way around." That's what I was working on there.
Bill Leibfritz	Questioning, checking, understanding. "Do you understand why you got what you did?" At certain points throughout the problem-solving process, we need to check for understanding. "Are you clear on where you are right now? Where are you going?" Also within the problem process, we are hearing the word *perimeter* pop off again. They are doing some practical geometry that can be related to concrete aspects, not just geometry of some square or rectangle drawn on the paper. This has some real meaning to it. The kids can visualize it and actually get a good sense of it.
NCREL/IU	An alternative strategy that a teacher could employ is the use of an overhead during reporting out by small groups to the whole class. Because they are reporting back on something that is sitting right in front of them, the other students really don't have any other mode of following along except for listening. A visual will provide a point of reference for the questions that the teacher skillfully poses to the students so the other people can understand how it is happening.

Event 11 cont.	Whole class discussion – Group three reporting their findings
Assessment	
NCREL/IU	During this event, it is clear that Dwight is putting an equal emphasis on the process by which the student arrived at the result as well as the result. Once again he uses probing questions to help the child really think through how he arrived at the answer. Dwight refers back to the diagram again to help the child structure and think about his own thinking.

Event 12 Dwight working with group three

Teaching Strategies	
Dwight Cooley	I encourage them to draw pictures and to make diagrams. I use a lot of hand gestures. It helps them to zero in on what I'm talking about. When I talk about perimeter, just by the way I move my fingers around, they think, "Oh, it's all the way around." It helps them zero in and focus on what it is they need to be thinking about. Eventually I won't have to do that.
Bill Leibfritz	We have a situation here where a student has some numbers in front of him, but he is not clear on what those numbers mean. He probably didn't generate them. They came from other people in the group, but again Dwight is making sure that this guy understands the numbers that the group has come up with and doesn't just go along with it. He tries to get the student to say what the number means. The student obviously is a little confused, so instead of telling him, Dwight asks one of the other members in the group to help him out with it. This is an excellent strategy.
NCREL/IU	Dwight helps the kids think about the numbers that they are using by having them associate those numbers with units that would give it some meaning, so it is never just "8," it is "8 panels." He could provide even more support to students in terms of helping them think about why they would use a particular operation to model an action in this problem situation. In this case, the action is one of separating the perimeter into various 8-unit panels, and understanding that they are using division because they want to achieve that kind of partition of the perimeter. "This is why I am using division or multiplication or addition, rather than another operation."

Event 12 cont. — Dwight working with group three

Problem Solving

Bill Leibfritz

The group is solving the problem. The teacher is not coming in and telling them what to do. If a group or a kid knows the teacher can bail him out every time they hit a snag, they will go to the teacher much more often. Let the group try to figure things out, even if it becomes a little anxiety provoking at times. It is good for them to see that.

Assessment

Dwight Cooley

In this event, you heard Stephanie say that you add it, and Mario clarified that right away. He said, "We didn't add it. We multiplied it." These kids are really tuned in—they're engaged in what's happening.

When I walk around and go from group to group, I am making sure that they are on task and are involved. When they are explaining what they did, and they can pick up from where another person leaves off, I know that they really understand it. It's easier to say the whole thing from the beginning to the end versus listening to someone else and taking up from there. The main thing is to keep them involved, keep them into it.

Bill Leibfritz

From an assessment standpoint, Dwight is still checking for understanding: "Do you understand how to solve the problem? What does that number mean? What does that 32 mean? How did you come up with it?" Some kids understood that and some didn't. They needed some extra attention.

Event 13 — Dwight explaining task of calculating cost and perimeter of chain-link fence

Teaching Strategies

Bill Leibfritz

All the kids are focusing on the wood fencing. Now Dwight is going to see if the kids can apply what they learned in that situation to the other type of fencing.

NCREL/IU

One of the things the NCTM standards talks about is that there is more than one right answer. It is good that Dwight—even though the students had one answer—pressed to see what the comparison was with the alternative type of fencing, so that they are not always thinking that they can stop at the end of one solution.

Problem Solving

Bill Leibfritz

We are going to switch to the other type of fencing, which again kind of flows into the problem-solving idea: "What have I learned?" One of the best types of mathematics is mathematics we learn from solving problems. The standards talk about this. We need to learn mathematics by way of problem solving, and that is what is going on here. And, likewise from a problem solving standpoint, Dwight is kind of going on an extension idea here: "Okay, he solved it with the wood, now what would it be if we went with the chain-link fence?" Covering that aspect, Dwight sees if the kids can make that application. If they cannot, you would have to almost come back and question whether they learned anything from the problem, even if they got the correct answer in the previous case. Kids need to learn mathematics by way of solving problems, and that is what is being attempted here. The perimeter notion keeps coming up; the division aspect keeps coming up; the idea of using multiplication is within this problem. All of them are within this. There is a lot of mathematics that can be learned and used in this situation.

Event 13 cont.	Dwight explaining task of calculating cost and perimeter of chain-link fence
Assessment	
Dwight Cooley	During the second part of this problem is where I'll be able to tell whether they really understood what they did, the process, the whole nine yards. I shouldn't have the same problems that I had the first time trying to get them to talk about the dimensions or whether to multiply or divide. They should just go right on through it. They have developed a procedure, and now they're applying the procedure to a different problem. They have written this procedure down, and so all they have to do is follow it.
Bill Leibfritz	Dwight is checking for understanding before moving on.

Event 14 — Dwight listens in on a small group working independently

Problem Solving

Dwight Cooley

They come to how many rolls and how much money very quickly now: They also know that they have to round 5.12 rolls up to six rolls.

Bill Leibfritz

The student comes up with an answer, and Dwight says, "Can you buy 5.12 links?" The kid right away says, "No, you can't do that." And they know that. But oftentimes all we do is get a computation answer. Kids will apply those computation answers and not think about, "Well, what does this number tell me? What does this 5.12 tell me?" The kids know you can't buy a .12 of a roll; you have to buy the whole thing, so you move up to the next roll. Oftentimes, the computation does not give us the exact answer. Kids seem to take that computation and interpret it. "This is what I got. What does it tell me?" But too often, because of the way that math is taught with so much emphasis on rote computation, we assume that the computation is the answer. In this case, it is definitely not, and in most problems it is not.

NCREL/IU

This is a good activity for determining the cost, but it seems like they are now focused on just using the criteria of cost, and they are not considering a broader range of criteria. Cost is not the only factor that they need to be using. They should be thinking about the safety, and perhaps other factors such as aesthetics.

Event 15 — Students working in small groups as Dwight circulates

Classroom Management

NCREL/IU

In this event, Dwight reemphasizes the individual accountability that each student has for participating within the small group. He is noticing that their attention span is beginning to dwindle a little bit, and he refocuses them and encourages them to hang with it.

Teaching Strategies

Dwight Cooley

With Geoff's group, this is one of those cases where one person takes control of the group, and what has happened is that Geoff did it quickly and he had the answer. Nobody else understood, so I directed Geoff to get everybody in the group on target, and I said that I would be back to find out how they did.

Bill Leibfritz

Dwight is requiring the kids to take some responsibility for what the whole group discovered. Probably each member of the cooperative group added his or her strength and was a valuable part of the group and now it is time for everyone in the group to learn. "Okay, what did you learn from it? What does each one of these mean?" You can see some of the kids are struggling a little bit with it, but they are trying to learn. They are learning from each other. They are not learning from what the teacher is telling them. They are learning mathematics by solving a problem. They are applying things they know, but they are also learning things that they didn't know.

Assessment

Dwight Cooley

I looked to see if they understood what happened in the last step. It shouldn't take me very long now. Somebody should be able to stand from each group and tell me the number of rolls, the cost, and how they got it, with no problem. I shouldn't have to worry about the perimeter because they already have it. Now it's just doing the procedure, exchanging numbers and different variables.

Event 15 cont.	Students working in small groups as Dwight circulates
Assessment, cont.	
Bill Leibfritz	Every individual is responsible for taking away from this problem situation what the group found—not just the brightest kid in the group, not just the leader in the group. Everybody in the group is responsible, and Dwight is not really letting anybody off the hook. Each kid is responsible for learning from the problem.

Event 16 — Small groups calculating how much money they would save if they bought the chain-link fence

Classroom Management

Bill Leibfritz

If somebody would look at this section of the tape right now, it might appear that there is a little bit of unruliness going on, but actually the kids are getting more excited. They are coming to the point where they are deciding "Which one is going to be the better deal?" So they are kind of excited about what they are finding. They have had the ownership problem for a long time. There is a higher noise level than there has been, but it is productive. It is learning noise, and it is a very positive teaching strategy.

Teaching Strategies

NCREL/IU

This is an interesting event because they were looking at the option of buying the chain-link fence, which wasn't a choice that they were led to by their own inquiry. They had all preferred the wooden fence, so it seems as though it was a bit of an academic exercise to try to calculate the cost of the chain-link fence. They were coming up with an understanding of the sort of cost savings that they could get from buying the chain-link fence over the wooden fence, so this may create some discrepancy. It could be a discrepant kind of fact that provokes some thinking by dissidence.

Problem Solving

Dwight Cooley

Here we're into operations on the numbers. I told them to tell me how much they would save, and they had to come up with the operation to figure that out. They had to find the costs for both of them, so now they were into the problem solving. That's just part of the task.

Event 16 cont.	Small groups calculating how much money they would save if they bought the chain-link fence
Problem Solving, cont.	
Bill Leibfritz	They are continuing to learn about the saving of money based upon what they found. It is not just, "Okay, here are two prices. Which one is better?" which in essence is what they are doing, but this is related to a fence that goes around a pool, which has a perimeter. This continues down the line of all the things that they have been dealing with from a mathematical standpoint. Dwight very easily could have said, "If you have this amount of money and that amount of money, which one is more? How much more?" He could move on to something else, but the kids wouldn't learn anything from that. In this case, they are doing a comparison of cost that they generated, and I think it is extremely valuable.
Assessment	
Bill Leibfritz	From an assessment standpoint, again he is continuing to check for understanding and to be clear that the kids know what they have gotten out of this.

Event 17

Whole group – Groups stating their perimeters as each student writes down which group they think will save the most money

Classroom Management

Bill Leibfritz

Dwight is sensing the kids' excitement. They have been working for quite a while on a problem, and we know the attention span of children this age and their ability to focus for a period of time, and they are probably getting close to their limit. He reminds them that they need to get back together, they need to listen, but they are almost there. He doesn't get on their case, he lets them know they have been working well, they are almost there, they really need to focus.

NCREL/IU

Dwight does a fine job of helping them to stay focused as they move into this final activity.

Teaching Strategies

Bill Leibfritz

Dwight then has each kid determine which group they think will save the most money. He shifts from a group focus to an individual focus. Now each kid is going to focus on their own for a little while, kind of breaking away from the group for a few seconds.

Problem Solving

Bill Leibfritz

From a problem-solving standpoint, to me it is a continual process of learning here. "Okay, what have we learned and what can we look at down the road as another possible problem situation? We have all these numbers, but which one is going to save the most money?" So it is not just, "Okay, this is the most money and we are done." They are thinking about it and making an estimate, which is a good use of the problem-solving process.

Event 17 cont.	Whole group – Groups stating their perimeters as each student writes down which group they think will save the most money
Assessment	
Dwight Cooley	I wanted to see if they could give me an estimate or make a judgment on which group saved the most based on the perimeter, using the benchmark. I went to an individual estimate now. I was trying to get something from everybody. I noticed that someone was trying to influence another person in their group, and I just had to clear up that I wanted individual estimates.
NCREL/IU	He asked the kids to make individual estimates. This could be for the purpose of individual accountability in trying to see whether the kids understood the point.

Event 18 — Whole group – Each group telling how much money they would save

Classroom Management

Dwight Cooley

Look at how Noah and all of his group were cheering. They have been doing mathematics. They were at school, they were working hard, and they had this kind of a reaction—happy and feeling good about math, and it carries on. I want them to feel good about math, and I think that you can see right there that they feel pretty good about what we've done. We didn't lose anybody; we didn't ship anybody off to the office; we didn't have to put anybody into the corner—none of that had to happen. We have students from A to Z abilitywise, so it works. As long as they're feeling good about it, they start to get that confidence, and you can see the little lights shine, and then you can generally get them to understand and do any type of mathematics.

Bill Leibfritz

The kids are wrapping up, and Dwight is bringing some closure to the problem that they have been working on. That helps in the management process. It brings things around so the kids can see some closure, which is probably the pattern Dwight follows.

NCREL/IU

Looking back on the whole lesson, one of the things that was quite evident was that Dwight has set a classroom climate where the students are not only very willing and able to work together in small groups, but they have developed the special skills for listening to one another and for piggybacking off of each other's ideas. They do not need a lot of coaching and direction in terms of moving from small group to whole group, and they get to the task very quickly. The children also flow with the expectation of constantly justifying their thinking, speaking about mathematics, and using math language. They have a "ceremony" at the end of working together, celebrating the success that they have had.

Event 18 cont.	Whole group – Each group telling how much money they would save
Teaching Strategies	
Bill Leibfritz	Dwight is evoking a little competition, not that that is the most important, but kind of checking what each group did, bringing all the groups together again, which aids in the management process.
NCREL/IU	A nice ending to this particular problem was the celebration, a pat on the back, and, basically, that really is helping to focus on the whole-class learning that occurred. Dwight had three primary goals or objectives with this lesson: one related to cooperative learning and working in cooperative groups; the second related to the problem-solving process—going through the understanding and planning before they jumped to a solution; the third related to building a conceptual understanding of the concept of perimeter. Dwight could have debriefed at the end around those three objectives in order to give equal emphasis to the process and the objectives.
Problem Solving	
Bill Leibfritz	As far as the problem solving goes, he is continuing to use the notion of learning mathematics from it—not only which group saved the most, but why they saved the most. He went around and asked that: "Why did this group save more money?" The one kid said because theirs was bigger to start with, and that is probably a valid piece of mathematics to learn from this problem. It is not just because there is more money; it is because the initial situation was different. Again you have a good problem here for a lot of different situations. There is not a right or a wrong; there is not only one way to do this, or one

Event 18 cont.	Whole group – Each group telling how much money they would save
Problem Solving, cont.	
Bill Leibfritz, cont.	specific answer to come up with. There is one group that saved more, but there is a reason that they saved more. That doesn't mean that that is the best situation. There are a lot of possibilities here, a lot of ways to go with this, and a lot of discussion that can go from this kind of a problem.
Assessment	
Bill Leibfritz	Throughout the process here, Dwight is seeing that there are levels of understanding. He accomplishes this by questioning, by being involved, and by facilitating. He has a pretty good grasp which kids have a good understanding and which kids probably don't have as strong an understanding. It didn't appear to me that any of the kids were dramatically behind. There is a pretty good level of understanding throughout.

North Central Regional Educational Laboratory
1900 Spring Road Suite 300
Oak Brook IL 60521-1480
800 356 [illegible]